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Technology and Strategy: The Changing Security Environment in Space Demands New Diplomatic and Military Answers

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On the brink of being weaponized, space is becoming a military-operational environment. Proliferating anti-satellite weapons threaten space security and enable first strikes against military space assets crucial to conventional and nuclear forces. This affects the global strategic landscape and decreases crisis stability among major powers. As current arms control regimes are insufficient, Germany and NATO should push new initiatives to keep space peaceful and advance military planning should they fail.

Space Becomes a Contested Domain

It is no coincidence that NATO adopted its first dedicated space strategy in June 2019 and is considering to designate space as a domain of its own, equal to land, air, sea and cyberspace.[1] The latest reminder that space is turning into a military-operational environment came on 27 March 2019, when India performed a military feat that only the USA, Russia, and China had achieved before: It hit and destroyed a satellite orbiting Earth by means of a missile.[2] Meanwhile, the USA is considering to create a space force and, more worryingly, planning to station weapons in space.[3] France, again, is aiming to set up a space command as part of its air force in September this year.[4]

With the growing importance of space assets for military and civilian functions, space is also gaining strategic importance and features ever more prominently in military debates. A high military value of space assets increases the incentive for states to be able to attack an adversary's space assets and protect their own. To date, space has only been militarized: This means, space assets have been used for military purposes such as intelligence gathering and early warning. Now, however, space is on the brink of getting weaponized, and this will involve the deployment of weapons in space that can engage other space assets or even targets on Earth.

All these developments decrease the strategic and crisis stability among states. To address the changing security landscape in space, Germany should follow a two-fold approach: First, it should seek to develop new, and support existing arms control and non-proliferation regimes, especially in cooperation with its European allies. Second, it should work within NATO to designate space as a military-operational domain of its own and strengthen the alliance's capabilities and procedures regarding space.

The Infrastructure for Military and Civilian Space Activities

Space activities, both military and civilian, require the following infrastructure: first, the space asset itself, i.e. the satellite; second, the communication infrastructure,

i.e. the data links to send and receive information to and from space assets; third, launch systems that take the assets into space, and fourth, capabilities for space situational awareness (SSA) to minimize the risk of collisions in space. Altogether, the required technological infrastructure is very costly and technically demanding, certainly when compared to activities in aviation. However, the costs for the parts that make up the space infrastructure have been decreasing as a result of continuous innovation, and this is opening space activities up to more actors than ever before.

The Opening of Space

For most of its 60 years, human spaceflight was limited to a few technologically advanced countries, above all the USA and the former Soviet Union, which were able to develop, produce and maintain the complex space infrastructure required. Their competition for prestige and technological advances, which became known as the "Space Race", culminated in the landing of US astronauts on the moon in 1969. However, access to space has become fundamentally less exclusive over the comparatively short period of the past 20 years: Today, at least twelve states and several companies have emerged as space-faring entities. Moreover, while the military dimension was a key driver of space activities during the Cold War, commercial activities today shape a sizable part of the industry. In fact, about 60 percent of payloads launched into space in 2017 were commercial in nature.[5]

Technological innovation in computing, manufacturing, miniaturization, and launch-related technologies, as well as their proliferation have opened space for more states and a whole range of new actors, from commercial industries to universities interested in space research. Furthermore, the increased military and economic value of space, and the efforts to reap and protect this value will likely lead to an increased proliferation of space-related technologies. More states will either indigenously develop such technologies or procure them on the market, and thereby further accelerate the opening of space.

The Civil-Military Importance of Space Assets

Civilian and military activities increasingly involve, or even depend on outer space. Satellites enable navigation and the transfer of vast amounts of data. They have become critical to controlling military assets, such as uninhabited aerial vehicles (UAVs). Thus, space assets are enablers and multipliers of military force. They provide vital information for both, nuclear and conventional forces. In the civilian domain, commercial satellites provide many services, from communication and observation to remote sensing and navigation, and even time-stamping money transfers. Moreover, the civil-military ambiguity of assets is growing as commercial suppliers also offer their services (e.g. bandwidth on communication satellites) to armed forces, thereby complicating the distinction between military and civilian targets.

The Growing Importance of Space Triggers Anti-Satellite Weapon Development

The growing dependence of civilian and military activities on space assets increases the strategic value of space for a rising number of actors, both state and non-state. This, in turn, spurs considerations and investments into the security and defense of space assets. The proliferation of anti-satellite (ASAT) weapons is one consequence of this development.

Space assets have, from their earliest days, played a key role in the military. Since the 1960s, they have provided several critical capabilities related to nuclear warfare to both superpowers, including weather forecasting, targeting, early warning, assessing damage and maintaining command and control. The ability to detect a nuclear first strike and respond to it with a second- or counterstrike was essential to the strategic balance of the Cold War, as it established the so-called Mutual Assured Destruction (MAD). At the same time, both superpowers came to understand that space assets are vulnerable, after testing ASAT weapons and especially after conducting nuclear tests in the upper atmosphere. The combined vulnerability and importance of space assets for the strategic-nuclear balance between the USA and the Soviet Union led both states to abstain from deploying ASAT capabilities on a large scale, though both developed and tested such systems.

Since then, the military relevance of space has diversified: The Second Gulf War in 1991 demonstrated to the involved militaries and to outside observers the added value of space assets for conventional military operations in the form of intelligence, navigation, communications, and munition guidance. Today, the destruction of an adversaries' space assets would not only affect its nuclear second-strike capabilities, but also decrease the effectiveness of a wide range of conventional military assets.

This boosts the incentive for countries to develop their space assets, for which the navigation satellite constellations of the EU (Galileo), Russia (GLONASS) and China (Beidou) are examples. At the same time, it incentivizes the development of ASAT capabilities that can be used either to threaten the space assets of an adversary and thereby diminish his military effectiveness via a first

strike, or to deter another actor by threatening to destroy his respective space assets.

Three basic types of ASAT capabilities can threaten space assets: These are kinetic weapons (e.g. missiles), non-kinetic weapons (especially directed energy beams), and capabilities which interfere with the electronic spectrum or digital components of space infrastructure, e.g., through cyberattacks or electronic warfare. These three types of weapons can be stationed in space, on the ground, or in the cyberspace / electromagnetic spectrum. Today, several states have such ASAT capabilities, above all, the USA, China, Russia, and India. Moreover, some countries field weapon systems that can be used to engage satellites (e.g. Israel), and others have the industrial capabilities and experience to develop and use them in the foreseeable future (e.g. European states and Japan). Thus, it is reasonable to expect more actors with ASAT capabilities in the future. This is likely to render the security situation of space assets more complex, since, for instance, deterrence measures will have to be designed to discourage more potential adversaries from attacks.

Anti-Satellite Capabilities and their Strategic Implications

The specific characteristics of space assets determine strategic calculations about space: Such assets are vulnerable; strikes against them are difficult to deter; the information they provide has an ambiguous impact on crisis stability, and they favor smaller actors. All these characteristics can have detrimental impacts on the strategic and crisis stability among states.

The Vulnerability of Space Assets Decreases Crisis Stability

Both, the vulnerability and the importance of space assets for military operations incentivize first-strike strategies that are designed to destroy an adversaries' space assets at the onset of a conflict and, thereby, decrease his other military capabilities. The actors know about the vulnerability of their space assets and are, therefore, particularly vigilant. This vigilance decreases crisis stability, which describes the balance of incentives for the involved actors to either de-escalate or further escalate a crisis.

Intricate Deterrence due to the Problems of Attribution and Time Compression

Deterrence is difficult to achieve for space assets, as they are so fragile that none would survive a well-coordinated first strike against them. They are classic "use-it-or-lose-it" assets, and this aspect further decreases crisis stability. Only a massive deployment of ground-based ASAT capabilities, that would enable a retaliatory strike so that both actors would lose their space assets, might counter-balance this to a certain degree, as it allows for a so-called deterrence by punishment.

However, even a (misinterpreted) threat to space assets could start a chain reaction and quickly escalate an incident in space to a wider war. Successful deterrence, therefore, requires situational awareness, attribution capabilities and resilient assets. Especially the latter two are notoriously difficult to achieve in space. While it might be easy to attribute a kinetic attack executed with a missile, the same is not true for ASAT attacks by other satellites, and, especially, not for cyberattacks and electronic warfare measures. Without clear attribution, however, it is difficult to deter any adversary, since he could speculate that an attack cannot be traced back to him – making deterrence and retaliation more difficult. Although cross-domain deterrence, i.e. threatening an actor through potential retaliation attacks on or by other-than-space assets, is always possible, it also amplifies the problems involved in traditional deterrence: A response has to be timely and proportionate, and it should not further expand of the conflict.

Furthermore, most timeframes for a potential escalation in space are measured in minutes, or even less for directed-energy and certain space-based ASAT weapons. As a result, both, decision-making processes and the humans deciding on military activities in space (e.g. a counterattack), are subject to very significant time compression. This also decreases crisis stability since it might further encourage an aggressive first-strike behavior prompted by the desire not to lose valuable assets.

The Ambiguous Influence of Information on Stability

The primary mission of most space assets is collecting and distributing information, and, as a result of this, crisis stability can be impacted in ambiguous ways. Information from space assets is key to four core security activities, which make it likely that a conflict in space and the loss of space assets will immediately spill over into other domains:

First, information is vital for the conduct of conventional military operations. Over the past three decades, Western and especially US armed forces have become dependent on information provided by space assets. Absence of space assets and their information would revert warfare to pre-space information conditions, and thereby make the movement of forces and communication among them more difficult. A more complicated movement and

sustainment of forces, again, would make conventional and expeditionary operations alike more demanding.

Second, military early warning and intelligence are crucial for nuclear forces and second-strike capabilities. They helped to stabilize the strategic balance during the Cold War. As a result, attacks against space assets performing such early-warning and intelligence tasks were considered too dangerous. It was presumed that such an attack would lead an adversary to assume the worst-case-scenario, i.e. an all-out nuclear attack, and then favor an equally destructive response. At least for Russia and the US, this is still valid today.

Third, an outage of intelligence space assets would decrease the quality of intelligence, surveillance, and reconnaissance, and, as a result, prompt a higher alert for conventional forces, since troop movements or military build-ups by an adversary could more easily go unnoticed.

Finally, space assets are used for the technical verification of compliance with international non-proliferation, arms control and disarmament regimes as well as embargos. Losing any space assets needed for these matters would also decrease a state's ability to check whether other agreement parties are, in fact, compliant. This uncertainty would increase the chance for misinterpretation and miscalculations, thereby undermine trust between countries, and decrease crisis stability.

More information can, thus, help adversaries to defuse tensions. From this viewpoint, more information, and the provision of the space assets required to garner such information must be regarded as conducive to stability. With easier access to space and more space-faring states, strategic stability might therefore increase.

However, space assets can also decrease crisis stability as they are prone to technical glitches. This was, for instance, obvious during the Cold War, when early-warning satellites misinterpreted light reflected from clouds as missile launches. Such misinterpretations nearly led to nuclear exchanges on multiple occasions.

Inherent Asymmetries Favor Small Actors

Given the vulnerability of space assets and their high value for the militaries which use them, the use of comparatively cheap ASAT weapons (especially in cyberattacks) can have disproportionally huge returns on investment. This is especially important for small actors who seek to attack or disrupt an adversary's military effectiveness and efficiency if it is based on space assets. By contrast, even a few space assets can bring significant benefits in the form of new intelligence information for any state, and this aspect is favorable especially to smaller actors provided they can afford the necessary resources. Consequently, these actors might profit massively from the easing of access to space that commercial innovation is bringing. This development, in turn, forces other space actors to review their thoughts about space security and consider more actors, which complicates the picture significantly.

Possible Options for the Protection of Space Assets in a Changing Security Environment

Actors seeking to protect their space assets can choose among four, possibly also combined, major options:

- They can opt for a more aggressive force posture and even field new ASAT systems that enable a first strike. Such activities will most probably further reduce stability, especially, if they take place in space. This is due to the time compression for decision making.
- Actors can start duplicating essential space assets, i.e. deploy more satellites which perform the same functions. However, this is bound to lead to growing numbers of ASAT capabilities to keep pace with a growing number of targets: If one actor increases redundancies or strike capabilities, others are likely to follow.
- Actors could also reduce the role of space in their commercial and military activities. However, this would require substantial investments in the development of substitute systems. In view of a possible conflict in space, the nations less dependent on space assets are less vulnerable today.
- A final option would be to use many methods and technologies, like hardening, anti-jamming, or deception to develop and field a new generation of defensive or protected space assets, yet this would also require significant investments.

The vulnerability of space assets, the difficulty of deterrence and the inherent advantages for smaller actors regarding space assets all decrease the strategic and crisis stability among states with either space or ASAT capabilities. At the same time, effective countermeasures would require serious investments into the research and development, production and deployment of more resilient space assets. As a result, measures to retain stability are key in order to limit the risk of conflict or even war in space.

Existing Space Governance Instruments Fail to Ensure Stability

Unfortunately, space governance in the form of treaties, institutions, and initiatives has not yet managed to keep up with the various developments. The existing international conventions were developed during the Cold War and for a different framework, that was dominated by two space-faring superpowers and did

not experience the interference of private actors. Recent initiatives to regulate space activity and prevent the weaponization of space have not yet yielded any results: Among them are the "International Code of Conduct for Outer Space Activities" (ICoC), brought forward by the European Union, the group of governmental experts (GGE) to study potential trust and confidence-building measures for outer-space activities, or the "Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects" (PPWT), promoted by China and Russia. However, the former two lack a binding nature and thus entail a high risk of infringement. The latter, again, only covers clearly identifiable space-based ASAT weapons, such as missiles, guns or lasers, but does not address other ASAT capabilities, such as ground-based systems, cyberattacks or so-called suicide satellites in space.

Moreover, other arms control regimes are also unprepared to assure stability in space. Existing arms control treaties barely prohibit or even regulate the military capabilities and the equipment that are required for ASAT capabilities. With the demise of the "Anti-Ballistic Missile Treaty" (ABMT) in 2002, this coverage shrunk even further and is now limited to only one treaty, the 1963 "Partial Nuclear Test Ban Treaty" (PTBT), which prohibits nuclear explosions in outer space. As a result, new arms control efforts are necessary to decrease the probability that conflicts, or strategic and military competition will spill over into the space domain.

Existing non-proliferation treaties, foremost the "Missile Technology Control Regime" (MTCR) and the Wassenaar Arrangement (WA), are quite capable of limiting the proliferation of critical technologies and systems required for ASAT capabilities. However, they would need to include more states, especially emerging economies with ambitious military and space-related plans, i.e. China and India. Joined by more countries, existing non-proliferation agreements could provide enough barriers to at least slow the rapid proliferation of ASAT-related technologies – with the notable exception of cyber capabilities.

Tasks and Challenges for NATO and Germany

Promoting Strategic Stability and the Civilian Use of Space

Germany and NATO have a high interest in keeping space a peaceful domain and, therefore, in ensuring the current strategic stability as well as the use of space for civilian purposes. Furthermore, the destruction of their space assets would severely limit Germany's and NATO's military capabilities, as these depend on space assets for early warning, intelligence, communication, and navigation. Since no European country fields ASAT weapons, stability through deterrence could be achieved in the form of highly complex cross-domain deterrence, a total dependence on US ASAT capabilities, or the use of other diplomatic instruments like arms control and non-proliferation regimes.

New arms control regimes for ASAT capabilities have proven elusive during the past decades. One option for Germany is to continue to focus on non-binding codes of conduct, as it does together with the EU. This will keep the international debate on space norms going and create non-binding behavioral norms for space use, even though their security-enhancing effect would be limited due to the lack of verification mechanisms. Germany should also consider joining efforts to prohibit the stationing of weapon systems in space (e.g. the "Sino-Russian Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects" (PPWT)), even if such efforts today do not include ground-based ASAT weapons or cyber and electronic warfare capabilities. Nevertheless, space-based weapons are the most destabilizing type, while ground-based ASAT capabilities can provide an – albeit limited – stabilizing second-strike capability and, thereby, deterrence against an adversary's space assets, in case a conflict escalates. Finally, Germany should work toward the inclusion of more states into the existing non-proliferation treaties, especially the MTCR and WA. While the militarization of space is bound to continue and can even have stabilizing effects on global strategic stability, the weaponization of space would likely initiate a destabilizing arms race.

Such an arms race and the resulting instability increase the risk of escalation. Escalation of any conflict in space entails the danger of rendering space unusable for humankind for a long time. By far the most dangerous current threat to space assets is human-made debris. Besides the intentional destruction of space assets (e.g. to test indigenous anti-satellite capabilities) and collisions of inactive satellites, any increased activity in spaceflight inevitably increases the number of objects – mostly debris – orbiting Earth. It is estimated that debris has increased by 50 percent in just the past five years.[6] In the worst-case scenario, spaceflight and the use of space assets would become impossible due to the amount of debris that is orbiting earth, continually colliding and creating additional debris in a cascade also known as the "Kessler syndrome".

While Also Preparing for the Worst by Strengthening NATO's Role in Space

Given the importance of space assets for Western military and civilian operations, and the risk of negotiation failures in arms control initiatives, Germany should, however, also support NATO considerations to designate space as a military-operational domain of its own, set apart from land, air, sea and cyberspace. A domain describes a "critical macro maneuver space whose access or control is vital to the freedom of action and superiority required by the mission".[7] Designating space as such a domain would prompt NATO more closely to analyze its vulnerabilities in space and its dependence on both civilian and military space-based assets. This would increase NATO's understanding of the entanglement of space and non-space operations and facilitate considerations about deterrence and defense in space.

NATO member states will also have to answer two crucial questions for the alliance: Does an attack on the space asset of one ally constitutes an Article 5 incident? And will national space assets come under the command of NATO in case of an attack?

NATO's position on cyberattacks might serve as an example for integrating space into the Article 5-framework, especially given the fact that cyber- and electronic attacks on space assets are the most likely ones. NATO has so far kept the threshold for triggering Article 5 consciously vague in cyberspace, ultimately leaving it to the North Atlantic Council to decide whether to count an attack as an Article 5 event. A similar approach could be taken to cover non-physical attacks on space assets, while physical attacks could be covered by Article 4 of the North Atlantic Treaty, which states that allies can "consult together whenever, in the opinion of any of them, the territorial integrity, political independence or security of any of the Parties is threatened".[8] In the case of cyberspace, the alliance designated cyberattacks as a possible trigger for Article 5, even before it designated cyberspace as its own military-operational domain.[9] Given the close integration of most space and other military assets, it would further make sense for NATO members to subordinate their space assets to NATO supreme command in case of an attack on the alliance, just as with other military capabilities.

Declaring space as a domain would align NATO with some of its major members in this regard, since the USA[10], the UK[11], France[12] and Germany[13] all list space as an operational domain beside land, air, sea, and cyberspace. While NATO allies hold largely identical threat perceptions about the changing security environment in space, disagreements might arise over the importance of space and the re-allocation of resources (i.e. funds and personnel) toward developing NATO's instruments, structures, and capabilities in a future space domain. Furthermore, the debate about subordinating national space assets will, most likely, see diverging opinions within the alliance, especially by states with a high interest in retaining their strategic autonomy. Moreover, allies might disagree over the central question of whether to weaponize space – that is, to station offensive weapons in orbit –, or whether to pursue other instruments to increase their resilience, such as arms control regimes or more passive reactions like the duplication of space assets. Consequently, Germany should facilitate the political debate within the alliance about these open questions and potential challenges. As the scheduled NATO summit in London on December 3-4, 2019 will address "current and emerging security challenges",[14] space might become an important topic. It also has the potential to further deepen NATO's internal rifts if it is not properly addressed.

Finally, Germany should take the lead in more practical steps, e.g. in aligning the thinking and procedures in the alliance. This could be achieved, for example, by further strengthening the NATO Center of Excellence which deals with space-related issues, the Joint Air Power Competence Centre (JAPCC) in Kalkar. Strengthening NATO's space posture in general would be in the interest of Germany, also given that it is home to NATO's Allied Air Command in Ramstein, which would become even more important in the alliance's headquarter structure.

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Notes

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